Pressure Raising Time and Rate from a Saturation Temperature Ramp

Saturation temperatures at two pressures (IF97), the time to raise pressure at an allowed temperature ramp, and dp/dT at the start.

Method: Saturation temperature and pressure from IAPWS-IF97; dp/dT by central difference

Input parameters

Unit system: SI

Parameter	Value	Unit
Starting pressure (absolute)	2.0000	bar
Final pressure (absolute)	46.000	bar
Allowed saturation temperature ramp	100.00	°C/h

Calculated results

Parameter	Value	Unit
Saturation temperature at start	120.21	°C
Saturation temperature at end	258.78	°C
Time to raise pressure	1.3857	h
Pressure rise per kelvin at the start (kPa per K)	6.3261	kPa

Notes for this case

- A constant temperature ramp means slow pressure rise at first and fast later: pressure per kelvin grows with pressure.

Formula and method

$$t = \frac{T_{sat}(p_2) - T_{sat}(p_1)}{\dot{T}}, \quad \frac{dp}{dT}\Big|_{p_1}$$

Variables

p_1	Starting pressure (absolute)	Pa
p_2	Final pressure (absolute)	Pa
$\dot{T}$	Allowed saturation temperature ramp	K/s
$T_{sat,1}$	Saturation temperature at start	K
$T_{sat,2}$	Saturation temperature at end	K
t	Time to raise pressure	s
dp/dT	Pressure rise per kelvin at the start	Pa/K

Method and standards

IAPWS-IF97 saturation line: saturation temperatures at the two pressures, the time as their difference over the ramp, and dp/dT at the start by a central difference of the saturation pressure over ±0.01 K.

Assumptions and limits

- Uniform ramp.
- The ramp limit is on metal temperature; the drum and header metal lags the saturation temperature during a fast rise, so following the saturation ramp exactly is slightly non-conservative. Use the maker's start-up curve.

References

- Saturation temperature and pressure from IAPWS-IF97; dp/dT by central difference

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/steam/saturation-pressure-ramp

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.